THYROID
PHARMACOTHERAPEUTICS

Hyper vs. Hypo

	Hyperthyroidism	Hypothyroidism
Definition	Excessive secretion of thyroid hormones; hypermetabolism	Undersecretion or alteration in thyroid hormones; hypometabolism
TSH	↓TSH	↑TSH
Prevalence	1.3%	4.6%
Patient	Women>men 8:1 30-40 y/o	Women>men 10:1 30-60 y/o
Etiologies	Grave's disease, adenoma, toxic multinodular goiter, drug-induced thyrotoxicosis, carcinoma	Hoshimoto's disease Iatragenic (surgery, radioactive iodine, antithyroid drugs)
S&S	Expected S&S of hypermetabolism (except in elderly)	Vague compared to hyperthyroidism, can't tell w/o checking lab values

Hyperthyroidism

Immediate treatment: ↓S&S (can discontinue when patient feels better, when tachycardia subsides)

- **Propanolol**
  - β blocker
  - Helps block T4→T3 conversion
- **Diltiazem**
  - CCB, non-dihydropyridine
  - Used if β blockers contraindicated

Maintenance

Thiomides

- Inhibit TPO → prevents organification and coupling → blocks synthesis of thyroid hormones
- Once thyroid is at normal function, reduce dose by 30-70%
- Doesn't feel better right away: need to wait for body to deplete stores (T4 has long half life)
- Adverse reactions: rash, arthralgIas, leucopenia, agranulocytosis, hepatotoxicity
- Drugs used
  - **Propylthiouracil (PTU)**
    - Secondary MOA: inhibits peripheral conversion of T4→T3 (like propanolol)
    - Highly concentrated in the thyroid gland
    - Pharmacokinetics: 1 hr half life, 60-80% protein bound
    - Dosage: 300-400mg/d in divided doses to max dose of 1200mg/d, maintenance 50-300mg/d
  - **Methimazole (MMI)**
    - 10x more potent than PTU
    - Highly concentrated in thyroid gland
    - Pharmacokinetics: negligible protein binding, longer half life 4-6 hr
    - Tastes better

Permanent

- **Radioactive iodine**
  - MOA: disrupts synthesis, destroys follicular cells
  - Adverse effects: mild pain/tenderness, dysphagia, transient hair thinning, hypothyroidism
  - Advantages: cheap, easy to administer (1 dose, tasteless liquid), well absorbed, concentrates in thyroid gland, few side effects
  - Disadvantages: delayed onset of action (6-8 weeks to see improvement, 3-6 months euthyroid)
  - Absolutely contraindicated in pregnancy
- **Surgery (thymectomy)**
  - Take out all or part of the thyroid gland
  - Good candidates: patient with carcinoma, compressive goiters, contraindications to thiomides or RAI
  - Highly effective, one time deal
  - Adverse reactions: hypoparathyroidism, hypothyroidism (need to take hormone replacements for rest of life), reoccurrence of hyperthyroidism, hemorrhage, damage to nerves

Adjunctive

- **Iodine**
  - MOA: by giving more iodine, the body's defense mechanism is to stop production, thereby inhibiting hormone release and production
  - Short term use: not chronic, because eventually the body compensates
    - Acute symptomatic management
    - Prepares patient for surgery
    - Thyroid storm
  - Given as: potassium iodine (SSKI, Lugol's solution)
  - Adverse reactions: rash, drug fever, rhinitis, iodism (including metallic taste)
- **Lithium**
  - MOA: inhibits release of hormone
  - Adverse reactions: thirst, tremor, GI, CNS
  - Narrow therapeutic window → last resort
  - Thyroid storm
- **Corticosteroids**
  - MOA: rise in antibodies to the TSH receptor
  - Treats Graves' opthalmyopathy and thyroid storm
  - Adverse reactions: a lot of SE

Pregnancy

- Thyroid hormone is affected by estrogen
- ↑Binding proteins → total T4 appears elevated
- Need to measure free T4 and TSH levels
- Don't use radioactive iodine therapy, use surgery as last resort, use as low dosage of thiomides as possible
- PTU better than methimazole because crosses placenta less

Thyroid storm

- Medical emergency
- Risk factors: surgery, infection, trauma, pregnancy, metabolic disorders
- Treatment: supportive care, PTU (preferred for its ability to inhibit peripheral conversion of T4→T3), sodium iodine, beta blockers, hydrocortisone, elimination of precipitating factors

Hypothyroidism

Hormone replacement therapy

Levothyroxine sodium (synthetic T4)

- Synthroid, Unithroid, Levoxyl, Levothroid, Levolet, or generic
- Very small amounts: in mcg, *not* mg
- Drug of choice for hormone replacement
- When converting to levothyroxine, base the dose on patient's age and weight
  - Start slow and go slow (because of ↑HR); watch out for elderly and pts w/cardiac problems

Liothyronine (T3)

- Cytomel, or generic
- Not as useful as T3 as maintenance therapy alone, not generally recommended
- Short half life → fluctuation in serum concentration → side effects, difficult to monitor

Liotrix (combination)

- Thyrolar
- Ratio 4:1 of T4:T3
- Expensive $$$
- Doesn't work as well as expected, not generally recommended
- Perhaps useful in emergency cases like treating myxedema coma

Armour Thyroid (dessicated thyroid, natural)

- Potential for allergies from its source (hog, beef, sheep)
- Variable potency, unstable shelf life, and unknown bioequivalency
- Not generally recommended

Pregnancy

- Estradiol → ↑thyroxine binding globulin → need to ↑hormone replacement

Drug-drug interactions *that affect amount of levothyroxine needed*

Effect	Medications involved	Levothyroxine requirement
⇑ **TBG binding capacity**	Estrogens Oral contraceptive	⇑
⇓ **TBG binding capacity**	Androgens, salicylates, glucocorticoids	⇓
Enzyme induction	Phenytoin, phenobarbital, carbamazepine, rifampin	⇑
⇓ **Bioavailability**	Cholestyramine, colstipol, aluminum hydroxide, sucralfate, iron sulfate, calcium	Separated doses

Drug induced thyroid disorders

- **Amiodarone**
  - Can induce either hyper- or hypo-thyroidism
  - Due to its high iodine content → inhibits peripheral conversion of T4→T3 and ↓hormone secretion
- **Lithium**
  - Induces hypothyroidism
  - ↓Hormone synthesis and secretion
  - Bipolar patients take lithium

Myxedema coma

- Life threatening emergency
- Happens with long standing uncorrected hypothyroidism
- Precipitating factors: stress, infection, MI, trauma, surgery, cold exposure
- Treatment: supportive, elimination of precipitating factors, thyroid hormone replacement ASAP

Subclinical thyroid disease *a mystery!*

- Abnormal levels of thyroid hormone that don't have any specific S&S or thyroid dysfunction/therapy
- Subclinical hyperthyroidism
  - Associates with atrial fibrillation, dementia, osteoporosis
  - Can be caused by intentional over hormone usage (to lose weight, ↑energy, or ↑metabolism)
- Subclinical hypothyroidism
  - Risk factors: women, elderly, greater iodine intake
  - Clinical effects: poor obstetric outcomes, poor cognitive development in children